How to Support 1.8-V Signals Using a 3.3-V LVDS Driver/Receiver + Level-Shifter

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This document discusses how to use a 3.3-V LVDS driver or receiver with a level-shifter to support 1.8-V (and other low-voltage) LVTTL/LVCMOS signals.

Introduction

An LVDS driver, such as the DS90LV011A, accepts a single-ended LVTTL/LVCMOS input and translates it to a differential LVDS output, as shown in Figure 1. An LVDS receiver such as the DS90LV012A, on the other hand, accepts a differential LVDS input and translates it to a single-ended LVTTL/LVCMOS output.

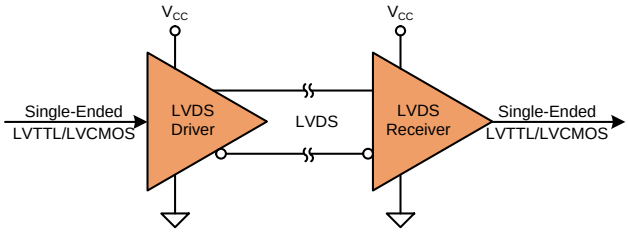

Figure 1. Operation of LVDS Drivers and Receivers

Sometimes there is a need to connect an LVDS driver or receiver to devices that are powered by low voltages (like 1.2 V, 1.8 V, 2.5 V, and so forth). The single-ended outputs of such devices normally have a voltage swing (V_{OH}-V_{OL}) that follows the supply voltage (see Figure 2). Also, the single-ended inputs of such devices accept a voltage swing (V_{IH}-V_{IL}) that follows the supply voltage. Therefore, the LVDS driver or receiver needs to support single-ended signals with low voltage swings, but most LVDS drivers and receivers available on the market have 3.3-V supplies and only support 3.3-V LVTTL/LVCMOS signals.

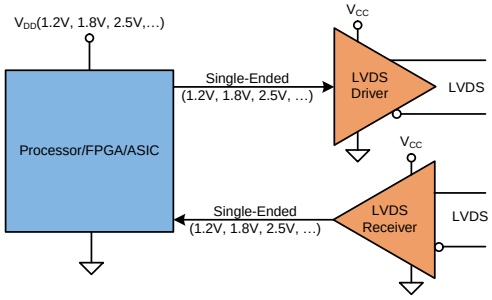

Figure 2. The Need for Low-Voltage LVDS Driver and Receiver

Solution

Figure 3 shows an approach to overcome this problem for the case when converting from low voltage single-ended signal to LVDS. A level-shifter, such as SN74AXC1T45, has 2 supply voltages, one for each side (V_{CCA} and V_{CCB}). V_{CCB} is connected to the same voltage supply for the source of the input single-ended LVTTL/LVCMOS signal, and V_{CCA} is connected to the 3.3-V supply of the LVDS driver. The single-ended input signal is fed to the level-shifter, which translates it to 3.3 V, and the output of the level-shifter is fed to the LVDS driver, which in turn converts it to LVDS signal.

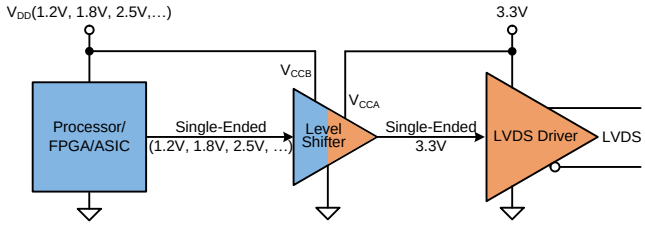

Figure 3. Using a Level-Shifter to Interface a Low-Voltage Device to a 3.3-V LVDS Driver

Figure 4 shows the implementation of this approach when converting from LVDS to a low voltage, single-ended signal. In this case, V_{CCA} of the level-shifter is connected to the same supply of the source of the input single-ended LVTTL/LVCMOS signal, and V_{CCB} is connected to the 3.3-V supply of the LVDS receiver. The LVDS input signal is fed to the LVDS receiver, which converts it to a 3.3-V, single-ended signal for the level-shifter. The level-shifter then translates the signal to a low voltage, single-ended LVTTL/LVCMOS signal.

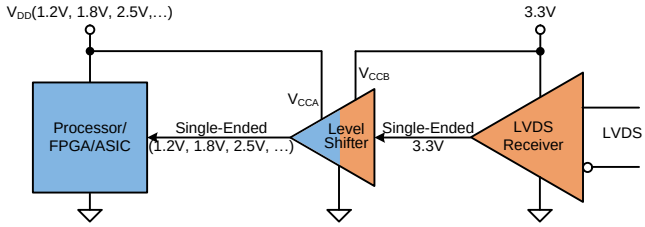

Figure 4. Using a Level-Shifter to Interface a 3.3-V LVDS Receiver to a Low-Voltage Device

Multi-channel signals (2, 4, or 8) can be supported when using this approach. Multi-channel LVDS drivers are available, such as the DS90LV027A (dual), DS90LV047A (quad), and SN65LVDS389 (Octal) devices. Multi-channel LVDS receivers are also available, such as the DS90LV028A (dual), DS90LV048A (quad), and SN65LVDS388A (Octal) devices. The level-shifters also have multi-channel devices, such as the SN74AXCxx45 family.

Solution Cost

The additional components necessary for this solution are:

1. Level-shifter chip
2. Two decoupling capacitors (one for each supply)

The additional cost is low, but depends on the selection of the level-shifter and discrete components associated with it (the two decoupling capacitors). The additional PCB area required for this solution is very small, but again is dependent on the size of the level-shifter used. The SN74AXC1T45, for example, is available in a variety of packages, including the space-saving X2SON package with an area of less than 1 mm^2.

Limitations

Some of the limitations for this approach are:

- The input signal voltage level supported is only limited by the type of level-shifter used. The SN74AXCxx45 family of devices support input voltages from 0.65 V to 3.6 V, so single-ended signals within this voltage range can be supported.
- The supported data rate with this scheme is the same as the supported data rate of the LVDS driver or receiver and the level-shifter. The LVDS drivers and receivers offered by TI generally support data rates of 400 Mbps or higher. The SN74AXCxx45 family of level-shifters support up to 500 Mbps when translating from 1.8 V to 3.3 V.

Conclusion

Using a level-shifter with a 3.3-V LVDS driver or receiver is a viable and economical option to support lower voltage LVTTL/LVCMOS input signals such as 1.2 V, 1.8 V, 2.5 V, and more.

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